MESOSCALE OCEAN FORECAST/ASSIMILATION STUDIES

Arthur J, Miller
Scripps Institution of Oceanography
La Jolla, CA 92093-0224
Phone: (619) 534-8033 fax: (619) 534-8561 ajmiller@ucsd.edu

Bruce D. Cornuelle
Scripps Institution of Oceanography
La Jolla, CA 92093-0230
Phone: (619) 534-4021 fax: (619) 534-8561 bcornuelle@ucsd.edu

Award Number "N00014-96-1-0264"

LONG-TERM GOALS

Our long-term goal over this two year project has been to develop computer software needed to optimize initial conditions, internal parameters and external parameters for the Harvard primitive equation (PE) model in order to produce the best forecasts in an arbitrary region. This new tool invokes an inverse technique to fuse all availble data types, gathered non-synoptically, with optimized model dynamics. The technique is distinct from (and complementary to) the optimal interpolation and Kalman filter assimilation strategies now being developed and used at Harvard.

OBJECTIVES

Specific scientific objectives of this research include answering the following questions. Can forecast skill in a highly unstable region like the Iceland-Faeroe Front be extended to 7 days? How sensitive are forecasts in that region to details of topography? Can a diagnostic simulation over a 10-day interval in that region include all the data in an inverse calculation, or is it too nonlinear? What are the relative impacts of the various data types (CTD/XBT/XCTD casts, current meters, surface drifters) on making forecasts in this region? The technical objectives encompass the details of the model fitting process. How nonlinear is the fit? Can the nonlinearity be reduced by optimizing large-scale structure first? How much data can be fit at one time? Is the distribution of the data sufficient to initialize the model? Are the open boundaries causing instabilities in the model?

APPROACH

Real-time ocean forecasting involves assembling an initial state which often requires merging many data types that are usually gathered over non-synoptic intervals. Furthermore, dynamical ocean forecast models still require improvements in their physics (including parameterizations). We are addressing these two issues simultanously in applying a standard inverse technique to the Harvard PE ocean model in the context of an unique dataset in the Iceland-Faeroe frontal region. The computational strategy that we are

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**
4. TITLE AND SUBTITLE **Mesoscale Ocean Forecast/Assimilation Studies**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of California, San Diego,Scripps Institution of Oceanography,La Jolla,CA,92093**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR’S ACRONYM(S)
		11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**3**	

developing will be applicable to whatever new regions, updated PE model versions, or varieties, amounts or qualities of data become available.

WORK COMPLETED

During the first year, we cleaned up and prepared the data, ported and designed the model domain and developed the iterative process for minimizing model-data mismatch. Since we had encountered possibly serious problems in applying the method to the dataset, we began the process of applying the model to `identical twin' data so that we could cleanly identify the source of the difficulty. After addressing those issues in the twin framework, we have begun the process of applying the technique to the real data and have some encouraging results.

RESULTS

From the twin experiments we learned that the initialization procedure works. We achieved simultaneously decreases in the model-data mismatch during the fitting time period combined with reduction of rms error over the entire field of the forecast. That is, we achieved improved forecast skill out to roughly five days in the time interval independent of the initialization data. At the same time, we found that since the independent data are sampled in reality only very coarsely, we did not find a significant reduction in error along that coarsely sampled `twin' track. In other words, because of limited validation data we cannot expect to prove that the model forecasts of the real data are signficantly better than persistence of day-0 or non-optimized forecasts even though they may very well be better. Our results also lead us to believe that nonlinearity, though strong, can be dealt with by applying several iterations. We also developed a better basis set of structure functions, upon which we construct the unknown initial error field, that is sufficeint to describe 75-90% of the variance of the error field in each layer.

We have subsequently applied the technique to the real data and found we can achieve easily a 50-75% reduction in error variance along the initialization track of XBT/CTD data. As might be expected from the twin experiments we did not find significant reduction of error along the verifying survey (a zig-zag track in the most energetic part of the front). We are presently exploring better estimates of data error bars, limits to predictability implied by nonlinearity and use of the second (zig-zag) survey as initial conditions.

We also have been developing the energetics analysis package (EVA) for the PE model. During a visit to IMGA-CNR in Bologna, Italy, Miller worked with Prof Pinardi on deriving the appropriate energy balance equations for the model and began programming the energetics package. Dr. Lermusiaux of Harvard aided in the coding of the routines to map sigma coordinates to z-level coordinates. Miller's Ph.D. student, Emanuele di Lorenzo, worked part time this past summer on merging the necessary routines for this package.

IMPACT/APPLICATIONS

We expect the procedure to prove useful in initializing ocean model forecasts at sea in real time. We also expect the optimized hindcast simulations to be useful in developing a better understanding of ocean physical processes, especially with the use of energetic analysis package.

A frontal region like the IFF presents an extreme challenge to the model fitting procedure, both in acquiring enough data and being able to adjust the model using a linearized iteration. If we can make it work in this situation, it should work in any application and could have

TRANSITIONS

This work is in the development stage and is not being used by others at this time.

RELATED PROJECTS

The ocean modeling group at Harvard is using and developing complementary assimilation techniques. We are begining a project, funded by NASA, to attempt to optimize predictability of the California Current System (using the CalCOFI CTD data with altimetry, ADCP profiles and surface drifters) using SCRUM and these inverse techniques.

REFERENCES

None.